

FILE COPY
NO. 2

Only Copy

TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

**CASE FILE
COPY**

No. 245

INVESTIGATIONS OF AVIATION ACCIDENTS AND
LESSONS TO BE DRAWN FROM THEM.

By F. Devaluez.

QUESTIONS FOR PUBLICATIONS SHOULD BE ADDRESSED

AS FOLLOWS:

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

1724 STREET, N.W.,
WASHINGTON 25, D.C.

January, 1924.

FILE COPY
To be returned to
the files of the National
Advisory Committee
for Aeronautics
Washington, D. C.

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

13

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM NO. 245.

INVESTIGATIONS OF AVIATION ACCIDENTS AND

LESSONS TO BE DRAWN FROM THEM.*

By F. Devaluez.

Investigations of aviation accidents are of especial importance on account of the technical information to be obtained, as well as to establish the responsibility for their occurrence. Such investigations must, therefore, be made with the greatest care. Judging from the regulations published by each country, it would appear that all possible precautions have been taken in this respect.

Excepting for differences in the method of procedure, the regulations are very similar in the different countries. It is, in fact, probable that the ones who have been called to make the rules have been guided by the same experience and the same desire to draw profitable lessons and it is therefore natural that even without previous agreement, they should formulate regulations which might equally well be international. These regulations may be briefly summed up as follows:

a) Investigations of accidents shall be made as promptly as possible;

b) The wreckage of the aircraft shall not be touched before the arrival of experts, except to succor the victims;

* Paper read at the International Air Conference, London, June 25, 1923.

c) Investigations shall be made by specialists accredited by authorities capable of assisting in their work;

d) Witnesses shall be sought by the nearest officials and interrogated with the least possible delay.

Knowing the general plan of organization common to all nations having aircraft, we will not enter into the details of the organization of the department which, in France, has charge of the investigations. This department was instituted in the Aerial Navigation Service and has functioned several years, during which time it has collected and compiled information on all aviation accidents in France. It has thoroughly investigated each accident, determined the facts and recommended the measures to be taken in order to prevent its recurrence.

Since the present article comes under "Group C," which has to do with commercial aviation, only accidents to commercial aircraft will be considered.

Although the statistics were compiled for France alone, we believe they will be of general interest without distinction of nationality. We believe, in fact, that they can be generalized on the assumption that, in all the countries, the conditions for recruiting the personnel are the same and that practically the same degree of perfection in aeronautic construction has been attained. We believe that aeronautic accidents occur in about the ^{same} proportion everywhere and that similar effects are due to similar causes. We also feel constrained to add the following observations.

The "Service de la Navigation Aérienne," in the statistics from which we have compiled our tables, has investigated all cases and taken account of all accidents, including those in which there were only very slight material damages. We consider, in fact, that only the cause is important, the results being slight or serious, according to the combination of fortunate or unfortunate circumstances.

However, as a matter of convenience, we have made a comparative table (I) showing the proportion of accidents according to their results. As in the tables which follow, the figures are given in percentage, but it would be superfluous to add that the figure of 100 accidents, serious and slight, has never been reached during a year in the French commercial air service. The percentage is, therefore, to be considered only in the relative sense.

Neither is there any thought of comparing the frequency of the accidents during the years 1921 and 1922, the sole purpose of these tables being to show the ratio of frequency existing in the cause of the accidents with respect to the total number of accidents. It is likewise simply for the sake of documentation and without pretending to draw any conclusions, that we have given the proportion of accidents in schools, training fields and for particular airplanes, the employment of aircraft under these very special conditions not being comparable with their employment in the regular exploitation of commercial lines, which only are now under consideration.

I.. Ratio in % of accidents in French commercial aviation between those causing only material damages and those resulting in personal injuries and death.

	Accidents causing only material damages.	Accidents causing personal injuries and death.
1921 { On air lines Aviation schools, training fields, particular air- planes	77.77% 63.88	22.22% 36.11
1922 { On air lines Aviation schools, training fields, particular air- planes	81.81 41.30	18.18 58.69

The following is a comparative table in which the accidents are classified according to their causes, but including only serious accidents resulting in personal injuries and death.

Causes of accidents.	On air lines.		Schools, training fields & particular airplanes.
	1921	1922	
Engine trouble over land	11.76%	9.52%	10.52%
Errors in piloting	29.41	--	52.63
Errors in piloting following engine trouble	17.64	23.8	5.26
Poor weather conditions	17.64	33.2	7.89
Poor condition of field	--	--	--
Airplane and propeller defects	--	4.76	2.63
Unknown causes	17.64	28.56	21.05
Collisions on ground	--	--	--
Imprudence of passengers	5.88	--	--

The following is likewise a comparative table on the same plan and under the same conditions as the preceding, but including, without distinction, all accidents and their consequences.

Causes of accidents.	On air lines.		Schools, training fields & particular airplanes.
	1921	1922	
Engine trouble over land	48.88%	47.72%	10.63%
Errors in piloting	17.17	11.16	63.82
Errors in piloting following engine trouble	8.88	2.27	2.12
Poor weather conditions	8.88	18.18	6.38
Poor condition of field	4.44	6.81	--
Airplane and propeller defects	2.22	9.09	8.51
Unknown causes	4.44	4.54	8.51
Collisions on ground	2.22	--	--
Imprudence of passengers	2.22	--	--

From this investigation it is evident that engine trouble over the land is the most frequent cause of accidents. In spite of the great progress already made, aviation engines are still far from perfect. It may be remarked, however, that engine trouble is nearly always due to some slight cause, such as the breaking of a valve spring, poor attachment of a rubber tube, leaks, poor ignition connections, etc. This fact indicates that security for aviation engines should be sought in improvement of details rather than in any radical change in design.

By analogy with the stages of progress in automobile construction, which has arrived at an almost final degree of perfection, it may be assumed that the airplane has reached the stage of development at which the automobile was, when, after emerging from the uncertain period of its beginnings, formulas of power and weight were established, corresponding very accurately to the needs for particular uses. The essential parts remained the same, but, each year, improvements in details marked considerable steps of progress. At the present time, it seems that the commercial airplane (to take only this example) should be a multi-engine airplane with a motive force of 500 to 1000 HP. That the proportion of accidents due to engine trouble did not diminish appreciably in 1922, as compared with 1921, was due to the facts that the airplane types in use on air lines were still poorly adapted to the purpose and that it was difficult to improve types which were justly considered provisional. It is very probable that, with the aid of experience, the year 1923 will mark an appreciable improvement in this respect. The proportion of accidents during 1921-22 was 87.30% for single-engine airplanes and only 12.69% for multi-engine airplanes, the latter having, in most instances, been able to complete their trips with only a portion of their motive force, or at least reach one of the emergency landing fields scattered along the routes. The use of multi-engine airplanes has not increased so rapidly as desirable, since such airplanes could not be employed

on certain long lines, because of their insufficient speed.

The next most frequent cause of accidents, after engine trouble, resides in the errors of pilots. We approach this subject with great reluctance, for fear of offending the susceptibilities of an elite personnel represented by the professional pilots. Nevertheless, we consider it our duty, in all impartiality, to call attention to the fact that the recruiting of certain professional pilots was not at first surrounded by all the requisite guarantees and that, consequently, pilots who could and should improve themselves, have not always taken advantage of their opportunities to acquire the knowledge they lacked. One fault of piloting, committed on normally regulated airplanes, has always been an error of judgment or lack of reasoning ability. Now, judgment and reasoning ability are acquired rather by cultivating the intellectual faculties, than by simply accumulating hours of flight. We have passed the period when the piloting of an airplane was simply a question of skill and our experience with pilots has proved the correctness of our view on more than one occasion. It is impossible, in fact, to ascribe to any other cause than lack of judgment any accident produced by climbing too steeply with a very heavily loaded airplane, or by starting with an airplane whose load is poorly distributed, or by trying to take off from a field bordered by obstacles and of insufficient dimensions. Such errors are not perhaps, properly speaking, simple errors of piloting, for this expression has never

been given a very definite meaning. They are no less serious, however, on that account.

We recognize the fact with pleasure, that certain pilots have made difficult daily trips for years with remarkable regularity, that they have never had any serious accident and seldom even very slight accidents. These pilots are men of judgment and forethought. They are thoroughly informed concerning their airplanes and know just why and how they fly. Much progress can and must still be made, in order to bring all pilots on airlines to the same degree of perfection. Good results have already been obtained in France by increasing the severity of technical examinations for the obtention of licenses. Moreover, the aerial navigation license which will soon be required of all air-line pilots and which some already possess, should bring all pilots to the desired degree of perfection. Great efforts have been made in this connection in France, both by the government and by private organizations, to establish a course of instruction to prepare candidates for the license of navigator and to fill in the gaps left by the too hurried instruction during the war. It will be remarked that the results obtained in this connection are very encouraging, the accidents due to errors of piloting having dropped from 17.17% in 1921, to 11.16% in 1922, and those due to the same errors following engine trouble having dropped from 8.88% in 1921, to 2.27% in 1922.

However skillful, judicious and thoughtful a pilot may become, he will never be entirely free from the danger of a momen-

tary lapse of attention. However great his vigilance may be, he will find himself helpless before the elements in certain cases when the weather is unfavorable. This is why too great importance cannot be attached to improving the navigation instruments, which, when atmospheric conditions are normal, render valuable service as instruments of control and which, when the pilot finds himself in difficulty, become powerful aids in surmounting obstacles: Great progress has been made in this connection, but many ingenious instruments are too delicate and complicated to be of much practical use. Moreover, there is prejudice to be overcome on the part of the pilots, many of whom are little inclined to use navigation instruments. Many make it a point of pride to disdain the use of such instruments, as if they were confident of possessing an absolute "sense of the air" corresponding to the sense of sight or touch. To pretend to be able to navigate under all circumstances without recourse to any instrument is as absurd as to pretend that a watch is superfluous because one has a slight notion of the time. The proportion of accidents which figure under the caption "Poor atmospheric conditions," and which was 8.88% in 1921, and 18.18% in 1922, illustrates the above statement, since the majority of the accidents entering into this proportion occurred in foggy or rainy weather.

The accidents ascribed to airplane and propeller defects call for the same remarks as those made with reference to accidents following engine trouble. They are due to slight causes or the rupture of parts which might be considered accessory and

to which too little importance is often attached, such as propeller ruptures during flight, rupture of landing gear axles, insecure fastening of a wheel. We will not return to this subject, which may be epitomized by the adage "Slight causes, serious consequences."

We will conclude this recital by noting that the accidents ascribed to unknown causes did not have mysterious causes. They were accidents in the investigation of which it was not possible to follow the principles set forth at the beginning of this article. Due to delay in undertaking the investigations, it was impossible to obtain all the necessary data, the wreckage having in some instances been cleared away before the arrival of the investigator, who, not being able to establish a certainty, preferred, in all honesty, to avow ignorance, rather than hazard a debatable decision.

The two remaining causes of accidents "Collisions on the ground" and "Imprudence of passenger" are entirely exceptional and are but distantly related to aerial navigation.

Lastly, since the preceding tables give the percentages of accidents for schools, training fields and particular airplanes, and although we do not wish to dwell on this category, we will briefly explain the figures, which might appear surprising in comparison with the data furnished by the air lines. Although in this list the accidents due to engine trouble are proportionally less frequent than on air lines, it is because, on the one

hand, the employment of engines in the schools or on touring airplanes is not comparable with their use on air lines. On the other hand, even if engine troubles were just as frequent, the consequences would be infinitely less dangerous, because the school airplane has an immense advantage over the commercial airplane, in having a good landing field near at hand, where, in spite of the mistakes of the pupil (often corrected by his instructor), it is possible to land without damage. Hence, it would be of no use to make comparisons between two such dissimilar categories. It is natural that the number of accidents due to errors in piloting should be much greater in the category which includes the schools of apprenticeship. In this respect, however, the year 1922 shows some improvement over 1921, probably due to improvement in the methods of instruction.

On summarizing this rapid recital, perhaps briefer than it should be for a question of such importance, we find that the problems, especially requiring the attention of those who are devoted to the future of aerial navigation, are the improvement of engines, the education of the navigating personnel and the construction of instruments for automatically correcting errors in piloting and for overcoming adverse atmospheric conditions. Marked progress has already been made and the results obtained during the first months of 1923 are very encouraging.

In the foregoing paragraphs we have frankly presented the situation as it is, because we believe that an accurate diagnosis,

based on facts, may enable the eminent specialists attending this Congress to find more surely the appropriate remedy for the "Crisis of growth" which aerial navigation appears to be passing through and may indicate for them the most direct route along which to conduct aviation toward its radiant future.

Translated by
National Advisory Committee
for Aeronautics.